

## WELDING AND ALLIED PROCESSES

### 1. SCOPE

1.1 Scope. This standard specification and appendices describe the general requirements for welding, fabrication, brazing, inspection and associated processes on Coast Guard vessels and equipment.

1.2 Appendices. The following appendices are part of this document:

PROCESS STANDARD	APPENDIX
Commercial Welding Standards	<a href="#">A</a>
Welding And Inspection - Naval Sea Systems Command And Military Standards	<a href="#">B</a>
Structural Boundary Tests And Non-Destructive Inspection	<a href="#">C</a>

### 2. APPLICABLE DOCUMENTS

BB-C-101, Carbon Dioxide (CO<sub>2</sub>), Technical and USP, 15 Apr 1971

QQ-B-654A, Brazing Alloys, Silver, 2/7/91

BB-H-1168, Helium, Technical, 3 Aug 2000

MIL-STD-0022D, Welded Joint Design, 21 Mar 1991

MIL-STD-777E, Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships, 7 Feb 1986 (Change 3, 01 Jun 1995)

MIL-STD-1627C, Bending of Pipe and Tube for Ship Piping System, 30 Sep 1994

MIL-STD-1689A, (SH) Fabrication, Welding, and Inspection of Ships Structure, 23 Nov 1990

MIL-STD-2035(SH), Nondestructive Testing Acceptance Criteria, 15 May 1995

MIL-A-18455, Argon, Technical, 7 Jun 1991

Naval Sea Systems Command (NAVSEA) 0900-LP-001-7000, Fabrication and Inspection of Brazed Piping Systems, May 1979

Naval Sea Systems Command (NAVSEA) S9074-AQ-GIB-010/248, Requirements for Welding and Brazing Procedure and Performance Qualification, Aug 1995

Naval Sea Systems Command (NAVSEA) T9074-AS-GIB-010/271, Requirements for Nondestructive Testing Methods, May 1997

Naval Sea Systems Command (NAVSEA) S9074-AR-GIB-010/278, Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels, Aug 1995

American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME), B31.5a-1994, Refrigeration Piping, and Addendum, 31 Aug 1994

American Society for Testing and Materials (ASTM) E142-92, Standard Method for Controlling Quality of Radiographic Testing, May 1992

American Society for Testing and Materials (ASTM) E164-97, Standard Practice for Ultrasonic Contact Examination of Weldments, Dec 1997

American Society for Testing and Materials (ASTM) E165-95, Standard Test Method for Liquid Penetrant Examination, Jan 1995

American Society for Testing and Materials (ASTM) E709-95, Standard Guide for Magnetic Particle Examination, Mar 1995

American Society for Testing and Materials (ASTM) E1417-99, Standard Practice for Liquid Penetrant Examination, 10 Feb 2001

American Society for Testing and Materials (ASTM) E1444-01, Standard Practice for Magnetic Particle Examination, 10 Feb 2001

American Society for Testing and Materials (ASTM) F1076-87, Standard Practice for Expanded Welded and Silver Brazed Socket Joints for Pipe and Tube, Reapproved 1997

American Bureau of Shipping (ABS), Rules for Nondestructive Inspection of Hull Welds, 1986

American Bureau of Shipping (ABS), Rules for Nondestructive Inspection of Hull Welds, 1986

American Welding Society (AWS) A2.4-98, Symbols for Welding and Nondestructive Testing Including Brazing. (DOD adopted), 1 Jan 1998

American Welding Society (AWS) A3.0-94, Welding Terms and Definitions Including Terms for Brazing, Soldering, Thermal Spraying, and Thermal Cutting. (DOD adopted), 23 May 1994

American Welding Society (AWS) A5.8-92, Specification for Filler Metals for Brazing and Braze Welding, 1 Sep 1992

American Welding Society (AWS) AWS A5.12/A5.12M-98, Specification for Tungsten and Tungsten-Alloy Electrodes for Arc Welding and Cutting, 5 Feb 1998

American Welding Society (AWS) B1.10-99, Guide for Nondestructive Inspection of Welds, 1 Jan 1999

American Welding Society (AWS) B1.11-00, Guide for the Visual Inspection of Welds, 1 Jan 2000

American Welding Society (AWS) D1.1-00, Structural Welding Code - Steel, 18 Oct 1999

American Welding Society (AWS) D1.2-97, Structural Welding Code - Aluminum, 17 Apr 1997

American Welding Society (AWS) QC1-96, Standard for AWS Certification of Welding Inspectors, 9 Dec 1996

American Society of Mechanical Engineers (ASME) B31, Codes for Pressure Piping, Aug 1998

American Society of Mechanical Engineers (ASME) B32.1-1952, Preferred Thicknesses for Uncoated Thin Flat Metals, Reaffirmed 1972

American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Codes, Section IX, Welding and Brazing Qualifications, 2001

The Society for Protective Coatings (SSPC), Surface Preparation Specification No.11 (SSPC-SP 11), Power Tool Cleaning to Bare Metal, 01 Sep 2000

Title 40, Code of Federal Regulations (CFR), Chapter I, Environmental Protection Agency, Part 63, National Emission Standards for Hazardous Air Pollutants, 1 Jul 1998

Title 40, Code of Federal Regulations (CFR), Chapter I,  
Environmental Protection Agency, Part 420, Subpart L, Iron and  
Steel Manufacturing Hot Coating, 1 Jul 1998

American Society for Nondestructive Testing (ASNT) SNT-TC-1A,  
Recommended Practice for Nondestructive Testing Personnel  
Qualification and Certification, 1996 Edition with 1998 Addenda

### 3. REQUIREMENTS

#### 3.1 General.

3.1.1 Compliance code. The Contractor shall follow all  
requirements of Appendix A unless otherwise specified in the work  
item (See 5.2 (Alternate Compliance)).

3.1.2 Welding documentation. The Contractor shall provide  
copies of the following information for all intended work to be  
performed, to the COR:

- A list of Weld Procedure Specifications (WPS's) and  
associated revision dates.
- Welder qualification documentation to include the last  
date the welder performed the indicated process.
- When requested by the COR, supporting Procedure  
Qualification Records (PQR's) and full WPS documentation.

3.2 Electronic equipment protection. The Contractor shall  
safeguard electronic equipment before welding to prevent damage  
from stray current and electromagnetic interference.  
Electrically isolate or disconnect ungrounded or sensitive  
equipment as necessary. Locate all welder ground connections as  
close to the work area as possible.

3.3 Advance notice. The Contractor shall provide the  
Contracting Officer's Representative (COR) with 24 hours advance  
written notice of all work planned including the weld procedure  
to be used.

3.4 Joints. The Contractor shall ensure the following:

3.4.1 Dimensions. Joint design and fit-up dimensions are in  
accordance with the applicable drawings, work item or  
requirements of MIL-STD-0022, unless otherwise indicated.

3.4.2 Welding terms and symbols. Welding term definitions and symbols shall conform to AWS A3.0, Standard Welding Terms and Definitions, and ASTM F1076 Standard Practice for Expanded Welded and Silver Brazed Socket Joints for Pipe and Tube as applicable.

3.5 Filler material restrictions. The Contractor shall be aware that low ductility shielded metal arc welding electrodes, including AWS classification E6010, E6012, E6013, E7014 and E7024, are not approved for joints in critical welds.

3.6 Process restrictions. The Contractor shall not use gas metal-arc welding (GMAW) utilizing short circuiting arc transfer technique for welds in ship structure above 0.25-inch material thickness, unless the process and application are specifically approved by the Contracting Officer (KO).

#### **NOTICE**

<b>The short circuiting arc transfer method is that in which a consumable electrode is deposited during repeated short circuits.</b>
--------------------------------------------------------------------------------------------------------------------------------------

3.7 Surface preparation. Before welding is begun, the Contractor shall power tool clean to "bare metal" all surfaces out to one inch on both sides of existing butt or seam welds to be repaired, in accordance with SSPC-SP 11, unless otherwise directed by applicable appendix.

3.8 Non-destructive testing (NDT). The Contractor shall inspect all welds in accordance with Appendix C, Paragraph 20.2 (Non-destructive inspections).

## **4. QUALITY ASSURANCE**

4.1 Documentation. The Contractor shall submit to the Contracting Officer's Representative (COR), within 24 hours after completing the repair work, a written report, in accordance with quality assurance requirements of all welding repairs accomplished. For welding accomplished in accordance with Appendix A, adhere to quality assurance requirements of the applicable code. For welding accomplished in accordance with Appendix B, adhere to quality assurance requirements listed in the appendix.

## 5. NOTES

5.1 Definitions. The following definitions are applicable to this document:

5.1.1 Activity. Activity refers to all sites of an organization under the same quality assurance management and using the same quality assurance plan performing work to which this document is applicable.

5.1.2 American Welding Society (AWS). Information concerning certification of welding inspectors, welders, and accredited test facilities for AWS welder certification is available on the world wide web internet at <http://www.aws.org>.

5.1.3 Approved (approval). Approval refers to when ABS, AWS, ASME, United States Coast Guard or authorized representatives have accepted the item under consideration.

5.1.4 Applicable data sheets. Refers to welding process data sheets or welding procedure specifications approved by AWS, ASME, ABS, NCPWB established welding regulatory code and regulations or their authorized representative(s).

5.1.5 Authorized representative. Authorized representative is any representative specifically authorized to approve equipment, material, or procedures for the referenced regulatory agency.

5.1.6 Corrugated Plate. Plate with a repetitive pattern utilizing bends in the plate as stiffeners, usually used in structural bulkheads.

5.1.7 Critical welds. Critical welds include but are not limited to welds on vessel hull plate, tank tops, structural decks and bulkheads, structural framing, and weight handling equipment.

5.1.8 Flat plate. A flat plate is considered as any plate that does not require pre-forming before installation.

5.1.9 Government inspector. Government inspector is a Government official who is charged with the responsibility for assuring that the materials, processes, fabrication techniques, inspections, tests, and testing personnel meet specification and contractual requirements. In this regard, he shall be the US Coast Guard MLCA Naval Engineering Support Unit Commanding Officer or his/her delegated representative.

5.1.10 Organization inspector. The organization inspector is the inspector of a Contractor, U.S. Coast Guard, or other agency who has been authorized by the regulatory organization to inspect and accept or reject materials and workmanship and to witness tests and validate test data.

5.1.11 Procedure qualification. A welding procedure qualification is an action by which test assemblies are prepared in accordance with a proposed procedure and evaluated either by destructive or non destructive tests or both.

5.1.12 Qualified. The term "qualified" means that the item under consideration has been approved as required by the applicable regulatory agency or authorized representative.

5.1.13 Qualifier. The qualifier is an individual or test facility designated by the applicable welding regulatory agency or contractor as responsible for conducting, supervising and accepting welder qualification testing. The qualifier shall be certified by the regulatory agency as a Certified Weld Inspector (CWI) or at a minimum be a competent individual meeting all the education and experience requirements of a CWI as defined by AWS QC1-96.

5.1.14 Shaped plate. A shaped plate is a plate that requires mechanical or other manipulation to pre-form the shape prior to the installation procedure.

5.1.15 Sheet Metal. A sheet material is any material identified by the Manufacturers' Standard Gage for Sheet Steel, a weight of 41.82 pounds per square foot per inch of thickness (e.g., 5.23 pounds per square foot per 1/8 inch of thickness), or conforming to ASME B32.1-1952 for copper and copper base alloy flat products whose thicknesses are below 1/4 inch.

5.1.16 Shell Plate. A shell plate is a plate forming the outer skin of the hull.

5.1.17 Welded studs. Welded studs include those studs attached to the structure by a welding or brazing process, designed to be a permanent part of the structure, or fasteners that are welded.

5.1.18 Welding procedure. Welding procedure is written instructions designed for use in production welding and repair welding, delineating all the essential elements and guidance to produce acceptable welds.

5.2 Alternate compliance. Commercial weld standards are preferred, however if a Contractor wishes to weld in accordance with Appendix B of this standard the Contractor must obtain authorization from the Contracting Officer.



## APPENDIX A

# COMMERCIAL WELDING STANDARDS

## 10. SCOPE

10.1 Scope. This appendix contains welding, fabrication and inspection requirements for welding and associated processes in accordance with commercial practices of American Welding Society (AWS), American Society of Mechanical Engineers (ASME) and American Society for Testing Materials (ASTM).

## 20. REQUIREMENTS

### 20.1 General.

20.1.1 Code selection. The Contractor shall select a commercial welding code and follow all requirements of the selected code for each welding procedure specification (WPS).

20.1.2 Mixing of code requirements. The Contractor may select different regulating codes for different weld procedures; however, all associated documentation, welding and welder requirements for each procedure (for example: the WPS, the PQR and the welder qualification and testing of the welds) must follow the same code.

### 20.1.3 American Bureau of Shipping (ABS).

20.1.3.1 ABS welding documentation. When ABS approved weld procedures and welder qualifications are to be used without the supervision of the ABS Surveyor, the Contractor shall ensure that all weld procedures and qualifications are approved by the Technical Office (located in Houston) of ABS in addition to the local surveyor. Be aware that the Coast Guard reserves the right for final approval of ABS weld procedures and welder qualifications.

20.1.3.2 ABS classed cutters. When working on ABS classed cutters the Contractor shall follow all ABS requirements to include the use of a ABS Surveyor, using ABS approved materials, following all ABS welding requirements and NDT. All welding paperwork must be approved by the ABS Technical Office (located in Houston) in addition to the local surveyor. Be aware that the Coast Guard reserves the right for final approval of ABS weld procedures and welder qualifications. The filler material restrictions listed in 3.5 (Filler material restrictions) still apply.

20.1.4 Code compliance. The Contractor shall be aware the Coast Guard maintains the right to review all documentation and welder performance to ensure code compliance. In the event a disagreement occurs concerning a violation of a self-regulating code (AWS or ASME), the Coast Guard shall make the final decision.

20.1.5 Additional requirements for HY-80, HY-100 and High-Hardenable Materials. The Contractor shall not use oxyfuel gas gouging for HY-80, HY-100, and high-hardenable materials.

## 20.2 Weld procedures.

20.2.1 Weld procedure specification. The Contractor shall have written welding procedures that comply with the Contractors' quality program for special processes and the requirements of the applicable regulatory agency code. Additional process restrictions are detailed within this document. The format of the welding procedure specification, specification test record, procedure qualification record, welder qualification test record, and nondestructive examination of weld documents are the Contractors choice, but shall delineate all of the essential elements and guidance required to produce and inspect acceptable welds(See 40.1). The regulating code shall be identified on each WPS.

20.2.2 Pre-qualified process welding restrictions. The Contractor shall not use welding processes identified by AWS as "Pre-qualified Standard Welding Procedure Specifications" on critical welds. For these noted critical applications, all weld procedures must be qualified by testing in accordance with the chosen regulatory code.

20.2.3 Standard weld procedures. The Contractor shall be aware that AWS Standard Welding Procedures are authorized for use in critical weld areas without procedure qualification.

## 20.3 Welder qualification.

20.3.1 Welder performance qualification. The Contractor shall ensure that all welding and brazing is accomplished by trained welders who have been certified by the applicable regulatory code performance qualification procedures. Performance qualification procedures may be in accordance with AWS, or ASME except as noted. Additionally, welders may be certified by a second tier agency, such as the Mechanical Contractors Association of America National Certified Pipe Welding Bureau (NCPWB), if such agency maintains uniform processes, qualification and welding procedures which conform with ASME Boiler and Pressure Vessel Code Section IX, the ASME B31 Codes for Pressure Piping, or American Welding Society standards. The Contractor must be able to prove the welder has been actively welding a process once every six months to maintain their qualification.

20.3.2 Method of establishing qualification. That Contractor shall ensure that each welder has satisfactorily completed a performance qualification test for the welds they are to perform. Performance qualification shall require completion of a standard test weldment in accordance with a qualified weld procedure, as well as evaluation and acceptance of the test weldment in accordance with applicable regulatory code. The following restrictions apply to welder performance qualification:

20.3.2.1 Standard test weldments shall be in accordance with all requirements of a qualified weld procedure. The qualifier is not authorized to make exception to any pre-heat, weld position, welding parameter, base material or filler material requirements.

20.3.2.2 Qualification by workmanship test is not authorized. Workmanship weldments are normally accepted or rejected on the basis of visual examination without radiography, bend test, bend-break test or macro-examination. This process does not provide acceptable evaluation of welder performance.

20.3.2.3 Qualification by workmanship test on a production weldment is not authorized.

20.3.2.4 Qualification of multiple welders or welding operators on one test weldment is not authorized.

20.3.2.5 Qualification by standard test is authorized on a production weld where the governing agency examination requirements permit the use of radiography in lieu of bend tests. The production weldment shall be evaluated and accepted by radiography in accordance with applicable regulatory code and requirements of this document.

20.3.2.6 The welding qualifier shall meet the requirements of paragraph 5.1.13 (Qualifier).

20.3.3 Individual qualification record (IQR). IQR certification and documentation shall be maintained by the Contractor for each welder in accordance with requirements of the certifying regulatory agency.

20.4 High strength steels. Where applicable drawings specify high strength, high tensile, special treatment steel or in particular HY material use in hull plate, structural members attached to the hull or weight handling equipment, the applicable weld data sheet(s) or welding process specification shall be specifically approved by the regulatory agency for the intended application and accepted by the government inspector prior to production welding. These weld processes shall meet the requirements of MIL-STD-1689.

20.5 Brazing requirements.

20.5.1 Joint design. Brazed joints shall be of the socket or sleeve types. The sleeve type fittings shall be used only where restriction prevents the use of socket type fittings for final closure joints. Fitting dimensions shall be as shown on approved drawings. Fittings for pipes and tubings larger than 0.840" O.D. shall be of the type having pre-inserted rings of brazing alloy, except the following joints may be of the face-fed type.

- Joints in freon (halocarbon) refrigerant systems.
- Joints for voice tube and pneumatic tube systems.
- Joints for bellmouth to pipe for tailpipes within tanks.
- Face-fed fittings shall not be used in other applications without specific approval of COR.

20.5.2 Assembly. Assembly of joints shall be in accordance with ASTM F1076.

20.5.3 Cleaning joint after brazing. Upon completion of brazing and cooling, remove excess flux and scale from the external surfaces of the brazed joint by either washing with water or wire brushing. No filing or grinding will be allowed on any portion of the joint or adjacent piping except when required for preparation of surfaces for UT inspection.

20.5.4 Cleaning and flushing. After cooling and prior to performance of pressure or leak testing, completed piping systems shall be cleaned and flushed to the extent necessary to ensure satisfactory operation of the system and components in service. Special cleaning, when required, shall be in accordance with specified requirements in the shipbuilding, overhaul or component specification.

#### 20.5.5 Repair of joints.

20.5.5.1 General repair process. The brazing alloy used in the repair shall be the same grade as used in brazing the joint. The joint area at the face of the fitting shall be re-fluxed before heating for repair brazing. All repaired joints and adjacent joints where re-flowing of the brazing alloy has occurred shall be subjected to the same nondestructive tests as required for the original joint. A total of only two repair attempts is permitted on a single joint. When repairs cannot be effected after two repair attempts, the joint shall be disassembled and re-brazed.

20.5.5.2 Repairs to improve bond or align fitting. Repairs to improve percentage of bond or align a fitting may be made by re-heating and re-flowing the alloy in the joint. Joints may be repaired by rotating, adding additional flux and/or supplemental face feeding and filleting. This method is applicable to newly fabricated joints or joints which have been exposed to fresh water, approved cleaning solutions, refrigerant or nitrogen. No more than two repair attempts shall be made.

20.5.5.3 Repair to fix leaks or weeps. Leaks or weeps may be repaired by re-heating to re-flow the alloy in the joint and/or supplemental face feeding and filleting. This method is applicable to newly fabricated joints or joints which have been in service regardless of the fluid which the system conveyed. No more than two repair attempts shall be made.

#### 20.5.6 Re-use of fittings and pipe.

20.5.6.1 Re-use of fittings. Fittings may be re-used subject to the limitations of ASTM F1076 and NAVSEA 0900-LP-001-7000.

20.5.6.2 Re-use of pipe. Unless otherwise specified, pipe may be re-used without inspection. Copper-nickel alloy pipe, intended for re-use shall be inspected as follows. After sizing, liquid penetrant inspect or visually inspect at 5X magnification entire periphery of pipe for length of 2D (nominal) or 2 inches (whichever is less) plus the socket depth. Cracked pipe or tubing shall not be used. If the previously brazed pipe is cut back for a distance of 2D (nominal) or 2" (whichever is less) plus the socket depth, this additional inspection is not required.

### 30. QUALITY ASSURANCE

No additional requirements.

## 40. NOTES

40.1 Commercial welding codes offer sample welding forms that are acceptable for documentation of welding processes and procedures. Contractors can find sample welding forms in AWS D1.1, AWS D1.2 and ASME Section IX.

## APPENDIX B

### WELDING AND INSPECTION

#### NAVAL SEA SYSTEMS COMMAND AND MILITARY STANDARDS

##### 10. SCOPE

10.1 Scope. This appendix contains welding, fabrication, brazing and inspection requirements for welding and associated processes in accordance with NAVSEA S9074-AR-GIB-010/278, MIL-STD-1689 (SH), and NAVSEA 0900-LP-001-7000.

10.1.1 Machinery, piping and pressure vessels. Welding and inspection for machinery, piping, pressure vessels and components shall comply with the requirements of NAVSEA S9074-AR-GIB-010/278 technical manual except as amended by this appendix.

10.1.2 Ships structure. Welding and inspection for Ship's structure shall comply with the requirements of MIL-STD-1689 (SH) except as amended by this appendix.

10.1.3 Brazed piping systems. Brazing and inspection for piping systems shall comply with the requirements of NAVSEA 0900-LP-001-7000 except as amended by this appendix.

10.2 Responsibility. The Contractor shall be responsible for submitting detailed welding procedures and processes that comply with applicable NAVSEA technical manuals or Military Standards. In addition, the Contractor shall ensure that all subcontractors have qualified procedures based on approved qualification data. Prior to production application of the welding procedures, the Contractor shall obtain approval in accordance with welding procedure qualification requirements of NAVSEA S9074-AQ-GIB-010/248. This entails submittal of the welding procedure qualification test report to the authorized NAVSEA representative for approval and submittal of the corresponding welding procedure to the authorized NAVSEA representative.

10.3 Weld procedures. Welding procedure qualifications previously prepared for other Government agencies, American Welding Society (AWS), American Bureau of Shipping (ABS), American Society of Mechanical Engineers (ASME), or other established regulatory codes may be submitted for approval to the NAVSEA authorized representative in accordance with limitations of NAVSEA S9074-AQ-GIB-010/248.

## 20. REQUIREMENTS

20.1 General. All references to weld joint symbols shall be interpreted in accordance with MIL-STD-0022 and AWS A2.4. Welding nomenclature and definitions shall be interpreted in accordance with AWS A3.0.

### 20.2 Applicable materials.

20.2.1 Base materials. Base materials shall meet the requirements of the applicable material specification listed in NAVSEA Technical Manual S9074-AR-010/278, MIL-STD-777, or MIL-STD-1689.

20.2.1.1 The following material designators used in U.S. Coast Guard drawings and working documents are equivalent for selecting weld data sheets and filler materials.

Ordinary Strength Steel	OSS
Carbon Steel, CS, Cfe	OSS
Mild Steel	OSS
High Strength Steel	HSS
High Tensile Steel	HTS/HSS
High Hardenable/Special Treatment Steel	STS

20.2.2 Welding filler materials. Filler materials shall meet the requirements of the applicable specification essential elements. Low ductility shielded metal arc welding electrodes, including AWS classification E6010, E6012, E6013, E7014 and E7024, are not approved for joints in critical welds.

20.2.2.1 Commercial specifications. Commercial filler materials for which there are no military specifications may be used when specified by COR. Such materials shall be procured to the designated specification and receipt inspected prior to use.

20.2.3 Brazing filler materials. The filler metals used in brazing shall conform to the requirements of ASTM F1076, Section 5, or AWS 5.8 Filler Metals Specification. Filler metals shall be limited to QQ-B-654A Grades III, IV, V and VIII. Filler metal QQ-B-654A Grade III shall be limited to joining copper and copper based alloys.

### 20.3 Other materials.

20.3.1 Argon gas. Shall conform to the requirements of MIL-A-18455.

20.3.2 Helium gas. Shall conform to the requirements of Federal Specification BB-H-1168, Grade A.



20.3.3 Carbon dioxide. Shall conform to the requirements of Federal Specification BB-C-101.

20.3.4 Tungsten electrodes. Shall conform to the requirements of AWS A5.12, EWTH-2, 2% thoriated.

20.4 Welder qualification. All welder and weld operators shall be trained and performance qualified in accordance with requirements of NAVSEA 9074-AQ-GIB-010/248.

20.4.1 Individual qualification record (IQR). IQR certification and documentation shall be maintained by the Contractor for each welder in accordance with requirements of NAVSEA S9074-AQ-GIB-010/248. All records of qualification shall be made available to the government inspector prior to production welding.

20.5 Equipment.

20.5.1 Grounds. The Contractor shall use adjustable ground clamps that are free of weld spatter, raised metal, etc., which could damage structure or components. Welding on machinery, pressure vessels, piping, ordnance, electronic, or fire control equipment shall have the ground return connection in the immediate vicinity of the work to ensure that current does not flow through bearings, pipe hangers, or other areas where arcing or high resistance paths exist. For purposes of providing a return path for welding current, Contractors shall use a grounding bar or lead which shall be connected directly from the machine ground return connection to the ship's hull, sized on the basis of 1,000,000 Circular Mils per 1,000 amps per 100 feet, but in no event using less than a Number One cable (85,037 Circular Mils). For vessels constructed of non-magnetic materials, the ground return cables shall be connected directly to the component being welded, as close to the weld zone as feasible.

20.5.2 Temperature-indicating crayons. Temperature crayons that contain elements such as lead, sulfur, zinc, cadmium, or mercury that could contaminate welds shall not be used.

20.6 Joint design and fit-up. Weld joint design and fit-up dimensions shall be in accordance with the applicable drawings, specification requirements or the authorized joint design sketch of MIL-STD-0022. All brazed joint designs shall meet NAVSEA 0900-LP-001-7000 except as detailed below.

20.6.1 Brazed joint requirements. All new or replaced pipe and tube bends shall conform to MIL-STD-1627, and brazed joints shall be of the socket or sleeve types. The sleeve type fittings shall be used only where restriction prevents the use of socket type fittings or for final closure joints. Fittings for pipes and tube larger than 0.840" O.D. shall be of the type having pre-inserted rings of brazing alloy, except the following joints may be of the face-fed type.

- Joints in freon (halocarbon) refrigerant systems.
- Joints for voice tube and pneumatic tube systems.
- Joints for bellmouth to pipe for tailpipes within tanks.
- Face-fed fittings shall not be used in other applications without specific approval of COR.

20.6.2 Brazed joint restrictions. All heating for torch brazing shall be accomplished with an oxy-fuel gas. No brazing shall be performed on non-ferrous piping greater than 4 inches NPS or on piping systems with wall thicknesses of 0.250 inch or greater without written specific Coast Guard engineering approval.

## 20.7 Joining requirements.

20.7.1 General. Welding shall be performed in accordance with the applicable approved data sheets. The welding parameters on the data sheets may be used for other than the designated joint designs when specified by NAVSEA or cognizant Coast Guard engineering.

20.7.2 Process restrictions. Gas metal-arc welding (GMAW) utilizing short circuiting arc transfer technique (the consumable electrode is deposited during repeated short circuits) shall not be used for welds in surface ship structure, unless the process and application are specifically approved by NAVSEA and Contracting Officer.

20.7.3 Joint preparation. In addition to weld buildup to correct oversize root openings, weld buildup may be used on surfaces or edges of materials in way of penetrations or connections prior to making joint fit-up. In all cases involving welding to correct excessive root opening, the joint edges shall not be joined until the oversize root opening is corrected to within the requirements of the applicable joint design.

20.7.4 Requirements for HY-80, HY-100 and high-hardenable materials. The use of oxy-fuel gas gouging is prohibited for HY-80, HY-100, and high-hardenable materials.

20.7.4.1 Use of torch heating. Torch heating for HY-80, HY-100 and high-hardenable material shall be confined to tack or temporary welding or to those applications involving welding within a localized area. When torch heating is used for welding operations other than for tack welding, the base material shall slowly be brought up to preheat temperature with sufficient time allowed for heat to penetrate the thickness of the parts being welded. The heated area should extend approximately 6 inches beyond the weld site directions. When torches are used for low temperature (60°F to 125°F) preheating, maintain metal temperature above ambient temperature for a few minutes before welding in order to minimize condensate caused by the flame.

20.7.5 Removal of austenitic or nonferrous weld material. When it is necessary to make ferritic welds over areas that previously contained austenitic or nonferrous welds, insure complete removal of the austenitic or nonferrous weld metal.

20.7.6 Repair of holes. Holes may be welded closed, provided the original hole diameter does not exceed 2½ inches and the material thickness is ¼ inch or greater. Holes ½ inch or less diameter shall be opened to greater than ½" minimum diameter. The opening shall be shaped to 20 degrees minimum included angle before welding close. Holes greater than 2½ inches original diameter shall be repaired by expanding the hole size for an insert.

20.7.7 Zinc coatings. Metallic zinc shall be removed from all joint surfaces on which welds are to be deposited and for a distance which will be at least 1 inch from the edges of the finished welds. The localized heating technique shall not be used for removing zinc coatings from HY-80/100, STS or similar chemistry, or quenched and tempered low alloy high strength materials. Removal and disposal of galvanizing or zinc coatings shall comply with the requirements of 40 CFR, Chapter I (Environmental Protection Agency), Part 63 (National Emission Standards for Hazardous Air Pollutants) and Part 420, Subpart L (Hot Coating), as well as all applicable state and local regulations regarding the testing, handling, storage, transportation, and disposal of generated hazardous wastes.

### 30. QUALITY ASSURANCE

30.1 General. All inspections of welded joints in machinery, piping and pressure vessels shall be performed in accordance with NAVSEA S9074-AR-GIB-010/278 except as modified in this appendix. All inspections of brazed joints shall be conducted in accordance with NAVSEA 0900-LP-001-7000 except as modified in this appendix.

30.2 Inspection requirements. Unless otherwise stated, inspections shall be performed in the final surface condition. Repairs to base materials or welds are to be inspected to the same requirements as the original base material or weld. Inspection shall be made when the material or weld is accessible for inspection to the degree necessary to confirm the joint is acceptable.

30.3 Methods. All inspections shall be as required within applicable specifications and shall be accomplished in accordance with the following procedures. Unless otherwise specified all acceptance criteria shall be in accordance with MIL-STD-2035, Class 1 acceptance standards.

- Visual Inspection (VT), NAVSEA T9074-AS-GIB-010/271
- Magnetic Particle Inspection (MT), ASTM E1444
- Liquid Penetrant Inspection (LPT or PT), ASTM E1417
- Radiographic Inspection (RT), NAVSEA T9074-AS-GIB-010/271
- Ultrasonic Inspection (UT), NAVSEA T9074-AS-GIB-010/271

30.4 Visual inspection. As a minimum, all welds shall be visually inspected by NDI/NDT or qualified welder. Welds requiring MT, PT, UT or RT shall in addition be visually inspected prior to final acceptance.

30.5 MT inspection.

30.5.1 General. Inspection shall be conducted in accordance with ASTM E1444. PT inspection may be substituted for MT where MT is impractical.

30.5.2 Final inspection. Final inspection of ferritic material shall be performed after all required machining or grinding has been completed, or may be performed prior to final machining when the inspected surface is within 1/32 inch of the final surface and the DC continuous method is used.

30.5.3 MT inspection exceptions. MT inspection is not required for backgouged roots. Additionally, MT inspection is not required for arc strike removal site, fabrication scars, nicks or gouges prior to repair welding.

30.6 PT inspection.

30.6.1 Weight handling equipment. PT inspection shall be performed on all completed welds deposited with austenitic or nonferrous electrodes in weight-handling fittings or fixtures supporting over 1 ton, unless the fitting or fixture is proof load tested after installation. Overlay or clad welding deposited on primary hull structure with austenitic or nonferrous weld metal for corrosion-resistance applications shall be PT inspected.

30.6.2 PT inspection exception. PT inspection is not required for clad welds used for wear-resistant applications.

30.7 Report. The Contractor shall document all weld inspections in accordance with welding surveillance inspection requirements of the applicable welding specification. All records of inspections shall be submitted to the Contracting Officer's Representative (COR), within 24 hours after completing the welding work.

#### 40. NOTES

NONE

## APPENDIX C

# STRUCTURAL BOUNDARY TESTS AND NON-DESTRUCTIVE INSPECTION

## 10. SCOPE

10.1 Scope. This appendix describes the requirements for testing of structural boundary testing and non-destructive inspection of welds.

## 20. REQUIREMENTS

20.1 Structural boundary testing.

20.1.1 Air test.

20.1.1.1 Precaution. Place a sign on each access of the space to be tested that clearly states the following phrases in upper case letters: DANGER, DO NOT ENTER, and COMPARTMENT AIR TESTING IN PROGRESS. (See 40.1.)

20.1.1.2 Set-up. Install the following at the test connection:

20.1.1.2.1 One vent valve.

20.1.1.2.2 Two relief valves arranged in parallel and set at 15 percent above test pressure.

20.1.1.2.3 Two independent pressure gauges, each with a range such that the pressure is in the middle of the scale.

20.1.1.2.4 An air supply of not more than 25 psig with a supply capability less than the exhaust capability of either relief valve.

20.1.1.3 Isolate. Isolate the compartment to be tested by blanking and or plugging all openings including lines and vents going to and from the space.

20.1.1.4 Pressure. Apply a two psig test pressure for 10 minutes. Observe the allowable pressure drops specified in table I. Prior to conducting the 10 minute test, pressurize the space for 15 minutes for temperature stabilization.

**TABLE I. ALLOWABLE TEST PRESSURE DROPS**

SPACE(S) TO BE TESTED	ALLOWABLE PRESSURE DROP
Tanks, voids, cofferdams	NONE
All others	0.1 psig

20.1.1.5 Leak detection. When the allowable test pressure drop is exceeded, the Contractor shall locate the leaks using either an ultrasonic leak detector or a soap solution applied to the opposite side of the structure.

20.1.1.6 Completion. After the air test, relieve the pressure and remove the blanks and plugs.

20.1.2 Water hose test.

20.1.2.1 Precaution. Prior to conducting a water hose test, the Contractor shall ensure all adjacent equipment is protected so no damaged will occur from any spray or fluid collection.

20.1.2.2 The Contractor shall conduct a water hose test by directing fresh water against the boundary being tested. The water hose nozzle shall be no less than 1/2" in diameter and the pressure at the nozzle no less than 50 psi. The nozzle shall be within 10 feet of the structure being tested.

20.1.2.3 Acceptance criteria. Successful test shall be noted by no evidence of water on the opposite side of the structure.

20.1.3 Air hose test.

20.1.3.1 Precaution. Safety glasses shall be worn at all times.

20.1.3.2 The Contractor shall conduct an air hose test by directing an air stream against the boundary being tested in a manner most likely to disclose leaks. An air pressure of 90 psi shall be supplied through a nozzle of about 3/8 inch diameter. The nozzle shall be held as close as possible to the joint or boundary being tested.

20.1.3.3 Acceptance criteria. Apply a soap solution to the opposite side of the structure to detect and locate leaks. A successful test shall be noted by no evidence of leakage indicated by no formation of bubbles in the soapy solution.

20.1.4 Chalk test.

20.1.4.1 The Contractor shall ensure the door or hatch is properly adjusted prior to conducting the chalk test. Chalk the bearing surface or knife edge and close the door or hatch by normal procedures. When the door or hatch is opened, the chalk from the knife edge will have been transferred to the gasket.

20.1.4.2 Acceptance criteria. A successful test is noted by a uniform and continuous chalk mark on the door's or hatch's gasket. Irregularities or breaks in the chalk mark are cause for failure.

20.1.5 Hydrostatic test.

20.1.5.1 Setup. Establish required prerequisites and initial conditions and align the system for testing.

20.1.5.1.1 Pressure gauges. Use two pressure gauges when performing hydrostatic tests; a master and a system gauge or temporarily installed gauge (with valid calibration dates) as a backup. The master test gauge shall have a scale range greater than the maximum test pressure, but not exceeding 200 percent of maximum test pressure. Before starting the test, crosscheck the backup gauge to the master test gauge, up to maximum test pressure. Use the master test gauge readings as the true pressures throughout the test.

20.1.5.1.2 There shall be no check valves or closed valves between the gauges and/or relief valves and the system or portion of the system being hydrostatically tested that would render system test pressure indication or overpressure protection inoperative or isolate portions of the system being tested from full test pressure.

20.1.5.1.3 Overpressure protection. Provision shall be made to relieve pressure trapped downstream of installed system. At least one manually actuated valve shall be provided for overpressure protection during all hydrostatic tests. At least one relief valve shall also be provided as automatic overpressure protection.

20.1.5.1.4 Test performance and inspection. Pressurize the system slowly and incrementally; do not exceed a rate of 100 psi/min. Visually inspect for leaks at normal operating pressure and two lower incremental pressures. Continue to increase pressure to hydrostatic test pressure. Visually inspect for leaks when test pressure is reached. Maintain the test pressure for fifteen minutes and throughout the inspection. After test completion, depressurize the system slowly to allow stresses to be equalized. Do not exceed a depressurization rate of 100 psi/min, remove all hydrostatic test equipment, including gags, blanks, and jumpers.



20.1.5.2 Welded piping system hydrostatic tests. The Contractor shall hydrostatically test welded piping systems to 135 percent of the system design operating pressure for 15 minutes, using clean, fresh water, except where specified in Table 2 below, with no allowable leakage or permanent deformation of pressure-containing parts.

20.1.5.3 Refrigeration system tests. The Contractor shall perform a system integrity test using a dry, inert gas, such as nitrogen or anhydrous carbon dioxide. Test piping and connections at 50% of system design operating pressure, but not more than 15 psig for R-11 refrigerant systems, 50 psig for R-114 systems, 100 psig for R-124 systems, or 75 psig for R-12, R-22, and 134a systems. Inspect all joints and connections in the system using a soap bubble solution. After leaks are repaired, and prior to initial system charging, the piping installation shall be inspected and tested in accordance with ASME B31.5.

20.1.5.4 Atmospheric system tests. The Contractor shall perform a hydrostatic water test of atmospheric and gravity systems including deck drains, plumbing drains, vents and overflow piping. Piping shall be subjected to a 10-foot minimum head of water for 15 minutes, without leakage. If the system is tested in sections, at least 10 feet of the higher section shall be retested, except the uppermost 10 feet, or less, of the system. In conjunction with the hydrostatic test, or separately, each plumbing fixture and drain shall be operated to assure unobstructed flow and traps maintain the required water seal.

20.1.5.5 Mechanical joined piping system operational tests. The Contractor shall test mechanical (i.e. threaded, bolted, etc.) system joints by performing an operational test of the piping system at the system design operating pressure for 15 minutes, using clean, fresh water, except where specified in Table 2 below, with no allowable leakage.

20.1.5.6 Tank hydrostatic tests. The Contractor shall hydrostatically test all feed tanks, storage tanks and similar vessels which contain only the static head of the acquired liquid to a pressure of 2 psig and hold the pressure for 15 minutes. Use clean, fresh water, or dry air except where specified in Table 2 below, with no allowable leakage.

**TABLE 2.    SYSTEM TEST MEDIA**

SYSTEM	TEST MEDIA
Lube Oil	System fluid
Hydraulic Oil	System fluid
Contaminated Oil, Ballast, or Seawater Systems	Seawater

20.2    Non-destructive inspections.

20.2.1    Inspection methods.    Inspection of welded joints is to be performed by approved nondestructive test methods such as radiographic, ultrasonic, magnetic particle or dye-penetrant inspection. Radiographic or ultrasonic inspection, or both, is to be used when overall soundness of the weld cross section is to be evaluated. Magnetic particle or dye penetrant inspection or other AWS Welding Inspection approved methods are to be used when investigating the outer surface of welds, or may be used as a check of intermediate weld passes. Inspection of welds shall be in accordance with general guides AWS B1.10, and AWS B1.11. Unless otherwise specified, all acceptance criteria shall be in accordance with MIL-STD-2035, Class 3 acceptance standards. Inspection shall be in accordance with the following procedures:

20.2.1.1    Visual inspection (VT).    Inspection shall be in accordance with AWS B1.11 or ABS Rules for Non-destructive Inspection of Hull Welds.

20.2.1.2    Magnetic particle inspection (MT).

20.2.1.2.1    General.    Inspection shall be in accordance with ASTM E709 and ASTM E1444 or ABS Rules for Nondestructive Inspection of Hull Welds. PT inspection may be substituted for MT where MT is impractical. MT inspection may be performed using wet or dry method, fluorescent or non-fluorescent particles and magnetic fields of circular or longitudinal method. No cracks are allowed.

20.2.1.2.2 Final inspection. Final inspection of ferritic material shall be performed after all required machining or grinding has been completed, or may be performed prior to final machining when the inspected surface is within 1/32 inch of the final surface and the DC continuous method is used. For inspection purposes, weld surface areas designed to be covered by other structural weldments (such as areas of longitudinal butt weld surfaces under frame welds or frame or stiffener weld areas covered by intercostals) are not considered finished welds until the covering weldment has been completed.

20.2.1.3 Liquid penetrant inspection (LPT or PT). Inspection shall be in accordance with ASTM E1417 and ASTM E165 or ABS Rules for Nondestructive Inspection of Hull Welds. No cracks are allowed.

20.2.1.4 Radiographic inspection (RT). Inspection shall be in accordance with ASTM E142 or ABS Rules for Nondestructive Inspection of Hull Welds. Acceptance criteria shall be in accordance with MIL-STD-2035 Class 3 acceptance criteria or ABS Rules for Nondestructive Inspection of Hull Welds.

20.2.1.5 Ultrasonic inspection (UT). Inspection shall be in accordance with ASTM E164 or ABS Rules for Nondestructive Inspection of Hull Welds. Acceptance criteria shall be in accordance with MIL-STD-2035 Class 3 acceptance criteria or ABS Rules for Nondestructive Inspection of Hull Welds.

20.2.2 Surface preparation for NDT. Inspection of completed welds shall be accomplished after slag removal and with the weld in the final surface condition. Power driven wire brushes shall not be used on surfaces that are to be liquid penetrant inspected unless the resulting surface is removed using an approved abrasive material prior to performing the inspection.

20.2.3 Weld examinations. The following welds shall be inspected:

20.2.3.1 All welds. All welds shall be visually inspected by NDI/NDT or qualified welder. Inspection prior to welding shall, at a minimum, include joint preparation, fit-up, and cleanliness. In process inspections, when required, shall be in the presence of the Coast Guard COR.

20.2.3.2 Weight handling equipment welds. PT inspection shall be performed on all completed welds deposited with austenitic or nonferrous electrodes in weight-handling fittings or fixtures supporting over 1 ton, unless the fitting or fixture is proof load tested after installation.

20.2.3.3 Overlay or clad welding. Overlay or clad welding deposited on primary hull structure with austenitic or nonferrous weld metal for corrosion-resistance applications shall be PT inspected.

20.2.3.4 Water and oil tight welds. In addition to the visual examination requirements, the contractor shall perform NDT, in the presence of the Coast Guard inspector, on all welds in shell plating, decks, watertight bulkheads and oiltight bulkheads.

20.2.3.5 Fillet welds 3/8 inch size and greater. The Contractor shall accomplish a surface examination, by appropriate nondestructive testing (NDT) methods, and in the presence of the Coast Guard Inspector, of fillet welds 3/8 inch size and greater.

20.2.3.6 Multi pass welds. For multi-pass full penetration welds, the Contractor shall examine the root pass in addition to the final surface passes by appropriate nondestructive testing (NDT) methods, and in the presence of the Coast Guard Inspector.

20.2.3.7 Loss of preheat. If the preheat temperature drops below minimum on incomplete welded joints in or to HY-80/100 (1-1/8 inches and over) or high hardenable materials (1" and over) the partially completed welds shall be VT/MT inspected.

20.2.4 Inspector qualifications. All individuals performing visual or NDI/NDT operations shall be knowledgeable concerning each of the principles and methods of examination required on the weldment. The qualification and certification of these inspectors shall be documented through the administration of written and hand-on practical examinations as performed by one of the following methods:

20.2.4.1 AWS Senior Certified Welding Inspector (SCWI) or Certified Welding Inspector (CWI) program

20.2.4.2 American Society for Non-destructive Testing (ASNT) Qualification and Certification of NDT Personnel, as detailed by SNT-TC-1A Table 1A, 1B, 1C or 1D. The inspector(s) shall be at a minimum certified to the ASNT Central Certification Program (ACCP) Level II certification.

20.2.5 Acceptance standards. The standards for acceptance of welding shall be in accordance with MIL-STD 2035, Class 3 acceptance standards for welds and NAVSEA 0900-LP-001-7000 for brazed joints. The Contractor shall repair all defects.

### 30. QUALITY ASSURANCE

30.1 Fuel filling system. Before conducting hydrostatic testing of fuel filling systems, ensure all manifold/stop valves, flow control valves, drain valves, and cross-connecting valves to other systems are properly closed. If any of these boundary valves to be closed have a pressure rating of 100 psi or less, they shall remain open to prevent disc distortion during testing. Install a blank flange downstream of the valve to provide the required test boundary.

30.2 Reports. Within 24 hours after completing the test, submit a written report to the Contracting Officer Representative (COR) stating the test results and identifying the location and extent of the leaks, if any.

### 40. NOTES

40.1 Notices. Before compartment air testing, the Coast Guard Inspector will announce on the ship's public address system that compartment air testing is in progress in the designated space and that personnel shall stand clear.